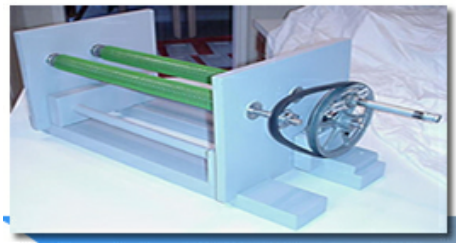
CONSTRUCT THE BIOREACTOR

Summary



This device vivdly depicts the concepts at work in the actual bioreactor developed by NASA. It allows students to control the rate of rotation of a clear, fluid-filled cylinder and suspend objects within in a state of freefall.
For demonstration purposes, it is best to use larger, brightly colored objects (i.e. colored golf balls).

Materials

2X4 Material (cut from 8' 2X4):
2 Part A's (Base) 1 1/2"X3 1/2"X30"
2 Part C's (Spacer block) 1 1/2"X3 1/2"X11"
1 Part J (Mounted bearing base) 1 1/2"X3 1/2"X6"

Handle Hardware
1 Galvanized Nipple 1/8"X5"
1 Galvanized Nipple 3/8"X4 1/2"
1 Galvanized steel coupling 1/8"
4 Flat steel washers 7/16"
2 I.P. straight brackets 1/8" (lighting hardware)

Misc Hardware
16 Flat head wood screws 1 1/4" long (2 per part B)
2 Flat washers for Part I, 3/8"
2 Nuts for Part I, 3/8"
2 Lead machine screw anchors for Part K, 5/16"X18
2 ss/Hex cap screws for Part K, 5/16"X18
6 self stick felt pads 1/8"X1 1/" dia
8 Flat washers for Parts F & G, 9/16"
1 C-clamp, 3"

Pine Shelving Material(cut from 1"X11"X4' pine shelving)
8 Part B's (slot block) 3/4"X2"X3 1/2"
2 Part E's (End board) 3/4"X11"X14"

Bearings
4 Part H's - 1/2"X1 1/8" OD Bearing
1 Part K - Mounted ball bearing; Dayton; 4X723 bore ball bearing, pillow block unit (Grainger Supply)

Container
Glass clamp top jar, 180 oz (The Container Store, stk #419070)

Other Parts
2 Part D's (Spacer dowel) 1"X18" Wooden dowel
1 Part I - 3/8" threaded rod X 24"
1 Part M - 1/2" X 2 1/2" Aluminum or steel rod
1 Part N - Sheave - 7" OD - single X 1/2" bore
1 Part O - Sheave - 1 1/2" OD X 1/2" bore
1 Part L - A type V-belt - 30"

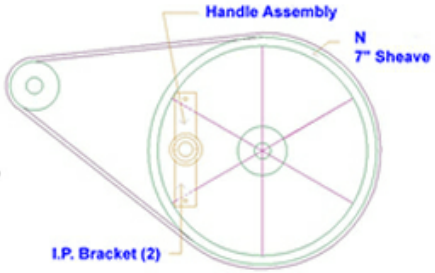
Steel Shafts (Cold rolled steel, from local machine shop)
1 Part F - 1 1/2"X25 3/8" with ends turned to 1/2" dia (1 5/8" long one end; 4 3/4" long other end)
1 Part G - 1 1/2"X22 1/4" w/ends 1/2" dia. (1 5/8" long both ends)
1 Part P - Flexible Polyethylene mesh sleeving, nonelastic 36" long, 1 1/4" dia. (green) (for F & G)
(McMaster-Carr Supply Co, 708.833.0300)

$200 to $250 Estimated Cost

Step 1 Sheave Handle Assembly

a. Attach I.P. Straight Brackets to 7" sheave (N) with screws and nuts.
b. Squeeze brackets together in middle and screw in 1/8" X 5" galvanized nipple through both threaded center holes; may need gripping wrench to assist screwing into brackets; use file to remove any metal burrs.
c. Place 2 or 3 metal washers onto 5" nipple; place 3/8" X 4.5" nipple onto 5" nipple; place washer and 1/8" steel coupling onto 5" nipple and tighten.

BIO-REACTOR HANDLE



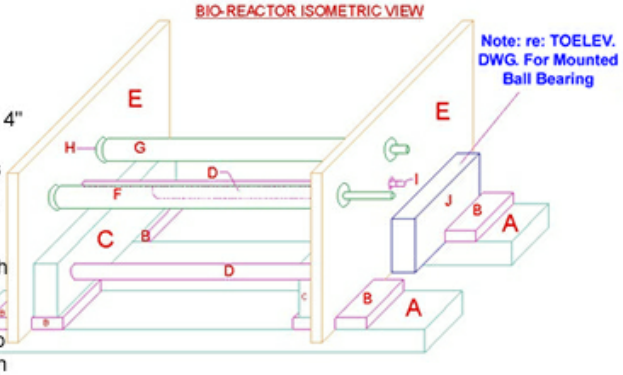
Step 2 7" Sheave Assembly

a. Tap 1/2" X 2 1/2" (part M) into mounted ball bearing; may need to file end of shaft parallel shaft length and apply STP Oil Treatment to shaft to allow for tapping into nearing.
b. Place mounted ball bearing (K) on wood block (J) and mark hole locations.
c. Drill 5/16" holes deep enough for screw anchors and tap screw anchors (5/16" X 18) into holes, flush with wood surface of J.
d. Anchor bearing (K) onto block (J) with 5/16" X 18ss/Hex cap screws.
e. Attach 7" sheave to shaft and tighten with Allen wrench.

Step 3 Bioreactor Assembly

a. Place 18" long poly sleeving (P) over each shaft centered on the 1 1/2" diameter length.
b. Place bases (A) parallel to each other about 4" apart (4" between inside edges).
c. Place end board (E, left-hand side) into slots with about 1 3/8" over-hang outside each base, and bearings extending toward right side end board position.
d. Place 2 washers (9/16") on each end of each shaft.
e. Place short ends of each shaft into standing end board, and move right-hand end board onto other shaft ends, moving end board into position in slots; bearings extend toward V-belt side of

BIO-REACTOR ISOMETRIC VIEW



right end board.

f. Place 3 self-sticking felt pads on outside edge of each spacer block, spaced evenly along the 11" dimension.

g. Assemble spacer blocks (C) and dowels (D) together to form spacer assembly; slide assembly between end boards, with felt pads against end boards, and assembly setting on top of bases (A).

h. Use rubber hammer or wood block and regular hammer to tap end boards fully into slots; make sure shafts spin freely.

i. Slide threaded rod through holes in end boards; place washers and nuts (9/16") on both ends and tighten until entire unit is rigid (washers will leave small marks on end boards when removed at dis-assembly).

j. Place 1 1/2" sheave on longest shaft end with Allen nut toward end of shaft.

k. Place large sheave assembly (7" sheave, mounted ball bearing and wooden block) into position between end board and slot block on back base (A).

l. Place V-belt over both sheaves.

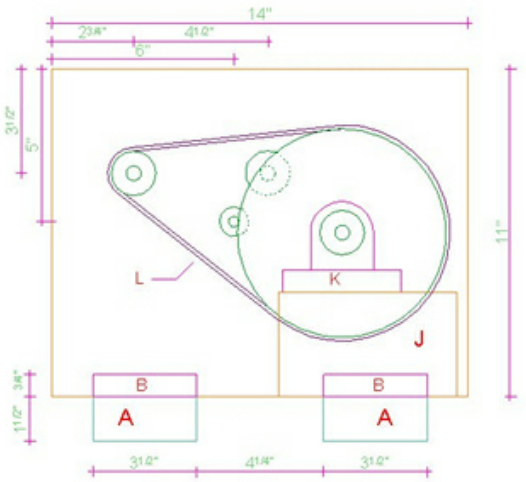
m. Adjust 7" sheave assembly so most slack in belt is taken out; use hammer and narrow block of wood to tap into slot; leave a little slack in belt or the shafts will not turn freely.

n. Adjust 1 1/2" sheave to same distance from end board as the 7" sheave and tighten Allen nut.

o. Assembly is now complete except you may need to apply a 3" C-clamp to end board and part J to hold sheave in place during operation.

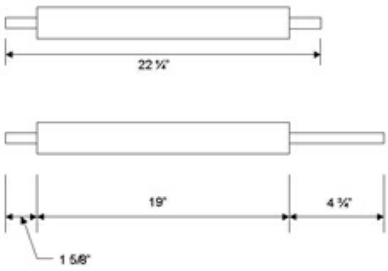
p. Place liquid filled container on shafts, with a golf ball inside, and turn crank.

BIO-REACTOR END VIEW

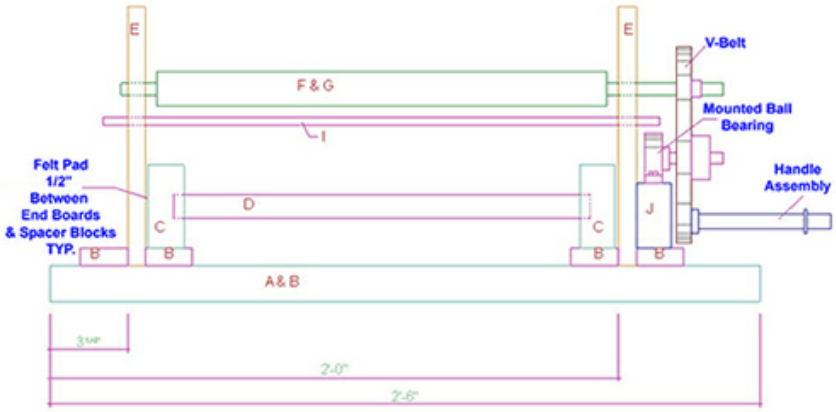


Bioreactor Shafts

1 ½" OD with ½" dia ends

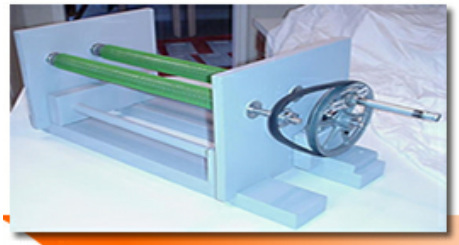


BIO-REACTOR FRONT VIEW



USE OF THE BIOREACTOR

Summary



This device vivdly depicts the concepts at work in the actual bioreactor developed by NASA. It allows students to control the rate of rotation of a clear, fluid-filled cylinder and suspend objects within in a state of freefall.
For demonstration purposes, it is best to use larger, brightly colored objects (i.e. colored golf balls).

Notes

The script calls for a Petri dish, and a lab coat for your volunteer. These items add spice to the performance but are not required.

Be sure to fill the clear cylinder completely with water - if adding the golf ball on stage, expect overflow and have some towels ready. If you add the golf ball pre-show, there will not be as much for your volunteer to do, but will prevent overflow.

Estimated Time
5 minutes

Step 1 Select a volunteer and place a lab coat on them - part of the fun!

Step 2 Explain the concepts involved as detailed in the script. Hand the golf ball to the volunteer and have them unsrew the lid to the clear cylinder, then place the golf ball inside and put the lid back on.

Step 3 Have the volunteer place the cylinder on the bioreactor turning device. Be sure it is centered and secure. You may need to assist.

Step 4 Have the volunteer to start turning the hand-crank. At the right speed the golf ball will become suspended and demonstrate the concept of freefall as achieved by the simple fluid physics of the bioreactor. If you are using a stage camera, focus in on the golf ball so the audience can see it sclearly on the TV.

Step 5 Give your volunteer a warm round of applause.